PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-234801

(43)Date of publication of application : 31.08.2001

(51)Int.Cl. F02D 43/00
F02D 13/02
F02D 41/22
F02P 5/152
F02P 5/153

(21)Application number : 2000-049777

(22)Date of filing : 25.02.2000

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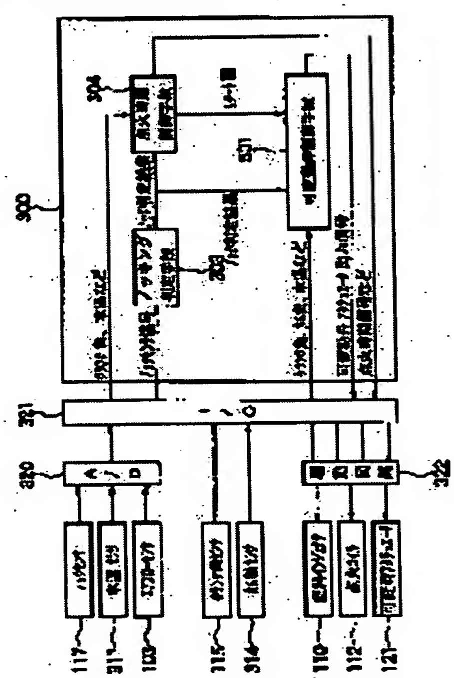
(54) KNOCKING CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an engine knocking control device which can reduce the ignition timing phase lag when the knocking is generated while ensuring the operability, avoid the knocking and minimize the exhaust temperature rise caused by the ignition timing phase lag, degradation of the fuel economy and output.

SOLUTION: The knocking control device 300 comprises a knocking judging means 303 to judge the presence/absence of the knock based on the knocking detection signal by a knock sensor 117, an ignition timing control means 304 to control the ignition timing based on the result of judgment, and a variable valve system control means 501 to variably control the valve timing of the engine, and when the presence of the knocking is judged, and the ignition timing is delayed, the opening/closing timing of an intake valve is delayed by the variable valve system control means 501 according to the phase lag.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to an internal combustion engine's knocking control unit, and relates to the knocking control unit which controls generating of knocking in the internal combustion engine for cars, such as an automobile, (gasoline engine) especially.

[0002]
[Description of the Prior Art] Engine high compression ratio-ization is considered as an improvement means in fuel consumption of the internal combustion engine for cars, such as an automobile, (it may be hereafter called an engine for short). However, engine high compression ratio-ization becomes the cause of reducing a knocking limit, and, for this reason, generating of knocking in a heavy load field poses a problem especially with the high compression ratio engine.
[0003] It is the phenomenon which big pressure imbalance arises in a combustion chamber, and the pressure wave generated by this excites a combustion chamber wall, and gets across to a cylinder crank case as everyone knows when the end of the flame propagation of gaseous mixture carries out self-ignition of the knocking in a gasoline engine in an engine combustion chamber.
[0004] It is necessary to control knocking to avoid an engine from a knocking generating condition at the time of knocking generating while avoiding if possible is desirable and it detects generating of knocking correctly for that purpose, in order to cause the fall of fuel consumption etc. further, loss (loss of power) of engine generating energy, the impact to each part of an engine.
[0005] Ignition timing is controlled based on the engine speed and load which are the parameter of an engine condition, and sometimes, he carries out the tooth lead angle of the ignition timing to a knocking limit, and is trying to usually sometimes suppress generating of knocking in the engine of an automobile from before from this viewpoint for the improvement in an output at the time of knocking generating.
[0006] In the engine with which such ignition timing control is performed, a knocking detection means detects knocking vibration. When it judges with having distinguished whether knocking occurred in the engine and knocking having occurred in the engine with the knocking distinction means For example, the lag of the ignition timing is carried out, and if it judges that knocking has not occurred after that, performing ignition timing lag control referred to as bringing ignition timing close to the optimal ignition timing gradually is known (JP,5-26778,A etc.).
[0007] Moreover, the knocking control technology of avoiding generating of knocking is shown by by equipping JP,59-93939,A and JP,8-33296,A with the adjustable valve timing device which makes adjustable closing motion timing of an engine inlet valve, and carrying out the lag of the clausilium stage of an inlet valve at the time of generating of knocking.
[0008] According to this thing, the lag of the clausilium stage of an inlet valve is carried out, and shortening an actual compression stroke for an inlet valve by open Lycium chinense, and reducing an engine real compression ratio and an engine charging efficiency till the gas column compression stroke first stage after the bottom dead point of an intake stroke is performed. If a real compression ratio falls,

since the knocking limit of ignition timing is offset at a tooth-lead-angle side, it will become possible to avoid knocking, without carrying out the lag of the ignition timing.
[0009] If the occurrence frequency of engine knocking is supervised and the occurrence frequency of knocking becomes high, ignition timing required for knocking evasion is calculated, the lag of the clausilium stage of an inlet valve is carried out at the same time it delays ignition timing, and the technology of avoiding knocking is shown in JP,11-036906,A.
[0010]
[Problem(s) to be Solved by the Invention] However, since an ignition quality rises rapidly in the knocking evasion by the lag of ignition timing as a compression pressure increases that it is an engine with a high compression ratio, mean effective pressure falls victim, and fuel consumption aggravation is not avoided, and an exhaust gas temperature rises at the time of heavy load high rotation, and it has the trouble of having a bad influence on engine endurance.
[0011] On the other hand, in the knocking evasion by the lag of the clausilium stage of an inlet valve, although the above problems by the ignition timing lag are not produced, carrying out the lag of the clausilium stage of an inlet valve influences the fall of engine power directly, and to avoid if possible is preferably desired on operability. Moreover, it is wanted to avoid if possible also from such a field by the lag of the clausilium stage of an inlet valve controlling an inhalation air content, and inhalation air content control being able to consider that the engine operation nature after avoiding generating of knocking will get worse once the clausilium stage of an inlet valve is operated to an engine output, since sensitivity is low to carry out the lag of the clausilium stage of an inlet valve.
[0012] Moreover, by what carries out the lag of the clausilium stage of an inlet valve, and avoids knocking, if the occurrence frequency of engine knocking is supervised and the occurrence frequency of knocking becomes high, since the lag of the clausilium stage of an inlet valve is positively carried out with the lag of ignition timing according to the occurrence frequency of knocking, the fall of engine power and aggravation of engine operation nature will become a problem too, at the same time it calculates ignition timing required for knocking evasion and delays ignition timing.
[0013] The place which this invention is made in view of the problem like ****, and makes into the purpose is using combining appropriately the ignition-timing control and the charging-efficiency control (adjustable valve train control or throttle control) at the time of well-known knocking generating, and it is for providing about the knocking control unit of the internal combustion engine which reduces having a bad influence on fuel-consumption aggravation and engine endurance, and avoids generating of knocking appropriately, securing engine power and engine-operation nature as much as possible.
[0014]
[Means for Solving the Problem] A knocking control unit of an internal combustion engine by this invention that said purpose should be attained A knocking detection means to detect knocking vibration generated in an internal combustion engine, A knocking judging means to judge existence of knocking based on a knocking detecting signal which said knocking detection means outputs, In a knocking control unit of an internal combustion engine having an ignition timing control means which controls an internal combustion engine's ignition timing, and a charging-efficiency adjustable means by which an internal combustion engine's charging efficiency can be changed Said ignition timing control means follows a judgment result of said knocking judging means, and if the judgment result concerned is with knocking Said ignition timing control means carries out the lag of an internal combustion engine's ignition timing, and said charging-efficiency adjustable means is characterized by reducing an internal combustion engine's charging efficiency according to a lag of ignition timing of an internal combustion engine by said ignition timing control means.
[0015] If according to this configuration knocking occurs in an internal combustion engine, it is judged with those with knocking by knocking judging means and the lag of the ignition timing is carried out by ignition timing control means, reducing a charging efficiency with a charging-efficiency adjustable means according to the ignition timing lag will be performed. It becomes possible to reduce having a bad influence on fuel consumption aggravation and engine endurance, and to avoid knocking, this securing engine power and engine operation nature as much as possible. In a concrete mode of a

knocking control unit of an internal combustion engine by this invention, said charging-efficiency adjustable means is characterized by being the adjustable valve train control means to which the lag of the closing motion stage of an internal combustion engine's inlet valve is carried out with an actuator.
[0016] If according to this configuration knocking occurs in an internal combustion engine, it is judged with those with knocking by knocking judging means and the lag of the ignition timing is carried out by ignition timing control means, carrying out the lag of the closing motion stage of an inlet valve by adjustable valve train control means according to the ignition timing lag will be performed. Falling an internal combustion engine's charging efficiency and securing engine power and engine operation nature as much as possible by this, it can reduce having a bad influence on fuel consumption aggravation and engine endurance, and knocking can be avoided.
[0017] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, when knocking is judged by said knocking judging means to be owner ** and ignition timing carries out a lag beyond a predetermined value by said ignition timing control means, it is characterized by carrying out the lag of the clausilium stage of an inlet valve with said good fluctuation valve-control means.
[0018] If according to this configuration knocking occurs in an internal combustion engine, it is judged with those with knocking by knocking judging means and the amount of ignition timing lags by ignition timing control means becomes beyond a predetermined value, carrying out the lag of the closing motion stage of an inlet valve by adjustable valve train control means for the first time will be performed. Falling an internal combustion engine's charging efficiency and securing engine power and engine operation nature as much as possible by this, it can reduce having a bad influence on fuel consumption aggravation and engine endurance, and knocking can be avoided.
[0019] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, it is characterized by performing lag discharge of a clausilium stage of an inlet valve gradually from a twist a time of the amount of ignition timing lags decreasing below to a predetermined value. According to this configuration, by returning gradually an inlet valve controlled by knocking control to basic valve timing from a time of the amount of ignition timing lags decreasing below to a predetermined value, rebound phenomenon to operability can be made into the minimum, and generating of knocking can be avoided.
[0020] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, during knocking control, inlet-valve control by said good fluctuation valve-control means according to an internal combustion engine's operational status is forbidden, and it is characterized by performing preferentially inlet-valve lag control for knocking evasion.
[0021] According to this configuration, although aim valve timing is calculated according to operational status etc. and valve timing is controlled, this control is forbidden, inlet-valve lag control for knocking evasion is performed preferentially, and adjustable valve train control can avoid generating of knocking, when knocking control is being performed. Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, said charging-efficiency adjustable means is characterized by being the throttle control means which reduces an internal combustion engine's throttle opening with an actuator.
[0022] If according to this configuration knocking occurs in an internal combustion engine, it is judged with those with knocking by knocking judging means and the lag of the ignition timing is carried out by ignition timing control means, reducing throttle opening by throttle control means according to the ignition timing lag will be performed. Falling an internal combustion engine's charging efficiency and securing engine power and engine operation nature as much as possible by this, it can reduce having a bad influence on fuel consumption aggravation and engine endurance, and knocking can be avoided.
[0023] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, when knocking is judged by said knocking judging means to be owner ** and ignition timing carries out a lag beyond a predetermined value by said ignition timing control means, it is characterized by closing a throttle valve by said throttle control means.
[0024] If according to this configuration knocking occurs in an internal combustion engine, it is judged

with those with knocking by knocking judging means and the amount of ignition timing lags by ignition timing control means becomes beyond a predetermined value, closing a throttle valve by throttle control means for the first time will be performed. Falling an internal combustion engine's charging efficiency and securing engine power and engine operation nature as much as possible by this, it can reduce having a bad influence on fuel consumption aggravation and engine endurance, and knocking can be avoided.
[0025] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, it is characterized by performing closing discharge of a throttle valve gradually from a twist a time of the amount of ignition timing lags decreasing below to a predetermined value. According to this configuration, by being gradually returned to basic throttle opening from a time of the amount of ignition timing lags decreasing below to a predetermined value, throttle opening controlled by knocking control can make rebound phenomenon to operability the minimum, and can avoid generating of knocking.
[0026] Moreover, in a concrete mode of a knocking control unit of an internal combustion engine by this invention, during knocking control, throttle control by said throttle control means according to an internal combustion engine's operational status is forbidden, and it is characterized by performing throttle closing control for knocking evasion preferentially.
[0027] According to this configuration, although aim throttle opening is calculated according to operational status etc. and throttle opening is controlled, this control is forbidden, throttle closing control is preferentially performed for knocking evasion, and throttle control can avoid generating of knocking, when knocking control is being performed.
[0028]
[Embodiment of the Invention] Hereafter, based on a drawing, the knocking control unit of the internal combustion engine of the gestalt of 1 operation of this invention is explained. Drawing 1 shows the engine system whole configuration equipped with the knocking control unit of the gestalt of this operation.
[0029] An air cleaner 101, an intake air flow sensor 103, throttle-valve equipment 121, the collector 105, and the inlet pipe 106 are connected to suction-port 100A of an engine 100 in order. The air which an engine 100 inhales is adopted from the entrance section 102 of an air cleaner 101, passes along an intake air flow sensor 103, passes along the throttle-valve equipment 121 which had the throttle valve 104 which controls an inhalation air content installed, and goes into a collector 105. The air inhaled by the collector 105 is distributed to each inlet pipe 106 connected to each cylinder (gas column) 107 of an engine 100, and is led to 107 in a cylinder.
[0030] Drive connection of the throttle motor 120 is carried out at the throttle valve 104, and switching operation of the throttle valve 104 is carried out by the drive of the throttle motor 120 electromotive. On the other hand, fuels, such as a gasoline, are pressurized by the low voltage fuel pump 109 from a fuel tank 108, and the pressure of them is regulated by the predetermined pressure by the pressure regulator 111, and they are supplied to the fuel injector 110. The fuel injector 110 is formed in suction-port 100A of each gas column, and the fuel injected from the fuel injector 110 goes into 107 in a cylinder with inhalation air, and is lit by the spark of the ignition plug 113 by the discharge voltage high-voltage-ized with the ignition coil 112.
[0031] An intake air flow sensor 103 measures an inhalation-of-air flow rate, and inputs the signal showing an inhalation-of-air flow rate into a control unit (engine control section) 114. The throttle opening sensor (not shown) is attached in throttle-valve equipment 121, and a throttle opening sensor detects the opening of a throttle valve 104, and inputs the signal showing throttle opening into a control unit 114. Moreover, the accelerator sensor (not shown) is formed in one at throttle-valve equipment 121, and an accelerator sensor detects the amount in which an operator operates an accelerator pedal 122, and inputs the signal showing an accelerator pedal control input into a control unit 114.
[0032] The crank angle sensor 115 is attached in the crank case portion of an engine 100. The crank angle sensor 115 detects the angle of rotation of a crankshaft 116, i.e., a crank angle, and inputs the signal showing a crank angle into a control unit 114. A control unit 114 controls the injection quantity of a fuel and timing, and ignition timing based on an above-mentioned input signal.

[0033] The inlet valve 123 which opens and closes suction-port 100A of an engine 100 is driven with the cam shaft 119. The well-known adjustable valve train controlling mechanism 118 is connected to the cam shaft 119. The adjustable valve train controlling mechanism 118 is driven based on the cam angle signal from the crank angle sensor 115 and the cam angle sensor 314 (refer to drawing 2) which detects angle of rotation of a cam shaft with the good fluctuation actuator 121 (refer to drawing 2) which uses the lubricating oil of an engine 100 as hydraulic oil, and the angular relation to the crankshaft 116 of a cam shaft 119 is changed.
[0034] The knock sensor 117 is attached near the center of the cylinder block of an engine 100 as a detection means of knocking. This knock sensor 117 is constituted by the piezoelectric device, and outputs the signal corresponding to the level of knocking vibration of an engine 100 to a control unit 114.
[0035] Drawing 2 shows the functional configuration of the knocking control unit 300 with which the engine control system 114 of drawing 1 is equipped and which is applied to the gestalt of 1 operation of this invention. The knocking control unit 300 has the knocking judging means 303, the ignition timing control means 304, and the adjustable valve train control means 501 that is a charging-efficiency adjustable means by which an internal combustion engine's charging efficiency can be changed.
[0036] The knocking control unit 300 inputs engine status information (for example, an engine speed, an inhalation air content, engine water temperature, the vehicle speed, etc.) into I/O Port 321 from the crank angle sensor 115, an intake air flow sensor 103, a coolant temperature sensor 311, etc., and inputs the output signal of the knocking sensor 117, and the output signal of the cam angle sensor 314 into I/O Port 321 as status information required for knocking control and adjustable valve train control. In addition, an analog input (an intake air flow sensor signal, a coolant temperature sensor signal, knocking sensor signal) is inputted into the knocking control unit 300 from I/O Port 321, after carrying out an analog / digital conversion with A/D converter 320.
[0037] The knocking control unit 300 calculates the amount of fuel supply, ignition timing, etc. based on the signal from each sensor, and outputs a control signal to an injector 110 and an ignition coil 112 through the drive circuit 322. Incorporation of the knocking signal in the knocking control unit 300 is sampled with A/D converter 320 synchronizing with the clock period of the knocking control unit 300, it changes the signal of the knocking sensor 117 into digital one with A/D converter 320, inputs this into the knocking judging means 303, and judges the existence of knocking with the knocking judging means 303. The judgment result of knocking in the knocking judging means 303 is inputted into the ignition timing control means 304, and the ignition timing control means 304 performs ignition timing amendment control based on the judgment result of knocking.
[0038] Next, the ignition timing amendment control in the ignition timing control means 304 is explained using drawing 3 . When judged with knocking having occurred with the engine 100 by the knocking judging means 303, the ignition timing control means 304 amends ignition timing to a lag side. Drawing 3 is the flow chart of the ignition timing control at this time. Actuation of this flow chart is performed every fixed time period, for example, 10msec, repeatedly.
[0039] First, engine-speed N and the inhalation air content Q are read from the predetermined register set as RAM within the ignition timing control means 304 (step 401). Next, inhalation air content Q/N per unit rotational frequency is calculated, fuel injection duration Ti is further found from Q/N, and fundamental-points fire stage thetabase is computed from the fundamental-points fire stage map currently held in ROM for fuel supply (step 402).
[0040] Next, a judgment result is inputted from the knocking judging means 303, and the existence of knocking generating is judged (step 403). If knocking has occurred, the predetermined amount deltathetaret of lags will be subtracted from current amount of ignition timing tooth lead angles thetaadv (step 404). The lag of the ignition timing is carried out by this subtraction. On the other hand, if knocking has not occurred, predetermined amount of tooth lead angles deltaadv is added to current amount of ignition timing tooth lead angles thetaadv, and amount of ignition timing tooth lead angles thetaadv is updated (step 405). Next, amount of ignition timing tooth lead angles thetaadv updated like the above is added to fundamental-points fire stage thetabase, and ignition timing thetaign of control

objectives is calculated (step 406).
[0041] Next, according to engine-speed N and inhalation air content Q/N, maximum tooth-lead-angle value thetares is calculated (step 407). Maximum tooth-lead-angle value thetares is determined by reading from the maximum tooth-lead-angle value map stored in ROM of the ignition timing control section 304. Next, if it judged whether ignition timing thetaign exceeded maximum tooth-lead-angle value thetares (step 408) and ignition timing thetaign is over maximum tooth-lead-angle value thetares, since it is a fault tooth lead angle, maximum tooth-lead-angle value thetares is set to ignition timing thetaign (step 409).
[0042] After ignition timing thetaign is set as the last as mentioned above, the print-out to an ignition coil 112 is set (step 410). Thus, it becomes possible by detecting knocking and controlling ignition timing to avoid an engine's knocking. Next, the adjustable valve train control by the adjustable valve train control means 501 is explained.
[0043] The adjustable valve train control means 501 is the same method as the above-mentioned, and engine water temperature and the vehicle speed are inputted. Moreover, the judgment result of the existence of knocking by the knocking judging section 303, The amounts of engine ignition timing adjustments (the amount of lags etc.) which are the results of an operation of the ignition timing control means 304 are inputted. From these input, the optimal valve timing is calculated, the output signal of the adjustable valve train actuators 121 (for example, solenoid etc.) is outputted to the adjustable valve train actuator 121 through the drive circuit 322, and valve timing is controlled. Next, actuation of the knocking control unit by this invention is explained below according to the gestalt of 1 operation. In addition, with the gestalt of this operation, an exhaust valve is a fixed phase and takes for an example the adjustable valve gear from which only an inlet valve becomes a variable phase.
[0044] Drawing 4 shows the flow chart of the adjustable valve train control action using the amount of ignition timing amendments. First, the processing flow shown in drawing 3 performs knocking judging processing and ignition timing amendment control by the knocking judging means 303 and the ignition timing control means 304 (step 121).
[0045] Next, it distinguishes whether it is beyond the predetermined value (adjustable valve train control initiation slice level Son) as which the amount of ignition timing amendments (the amount of ignition timing lags = the amount of ignition timing retard) was inputted, and the amount of ignition timing retard was beforehand determined from the ignition timing control means 304 (step 122). If ignition timing is under the predetermined value Son even if it is carrying out knocking generating, adjustable valve train control will not be performed but control will be ended as it is. By this, when the amount of ignition timing lags is small, inlet-valve lag control is not performed, but the usual operability can be secured.
[0046] On the other hand, if the amount of ignition timing retard is beyond the predetermined value Son, it will distinguish whether inlet-valve closing motion stage control has already been performed by the adjustable valve train control means 501 (step 123). If inlet-valve closing motion stage control is performed, the inlet-valve closing motion stage control will already be forbidden (step 124). Even if knocking has occurred depending on operational status, it forbids carrying out the tooth lead angle of the inlet valve, and carrying out the tooth lead angle of the inlet valve for the improvement in operability (for example, adjustable valve train control for a torque demand), in such a case.
[0047] Next, the lag of the closing motion stage is carried out for an inlet valve for knocking evasion (step 125), and knocking is avoided. About a setup of the amount of lags, it mentions later. Next, it distinguishes whether it is beyond the predetermined value (adjustable valve train decontrol slice level Soff) as which the amount of ignition timing amendments (the amount of ignition timing lags = the amount of ignition timing retard) was inputted, and the amount of ignition timing retard was beforehand determined from the ignition timing control means 304 (step 126). However, it is Son>Soff about the amount of ignition timing lags.
[0048] If the amount of ignition timing lags is larger than the predetermined value Soff, inlet-valve lag control will be continued, on the other hand if the amount of ignition timing lags decreases under to the predetermined value Soff, inlet-valve lag control will be canceled, and a tooth lead angle is carried out

so that it may become a basic inlet-valve actuation angle (step 127). Here, as for the tooth lead angle (lag discharge of the clausilium stage of an inlet valve) of the closing motion stage of an inlet valve, it is more desirable than the time of considering operability and the amount of ignition timing lags growing under into the predetermined value Soff to carry out gradually.
[0049] Moreover, when ignition timing returns at a fundamental-points fire stage, the predetermined value Soff here is setting up the predetermined value Soff with 0, the inhalation of air to an engine is stabilized by it, and its operability improves. However, since the time amount which is carrying out the lag of the ignition timing becomes long, to an exhaust-gas temperature, fuel consumption, and an output, it becomes disadvantageous. For details, it mentions later.
[0050] Next, the method of setting up the amount of inlet-valve lags for the knocking evasion in the gestalt of this operation is explained. However, since it is well-known to avoid knocking by the inlet-valve lag as mentioned above, it explains briefly using drawing 5 and drawing 6 . Drawing 5 and drawing 6 express change of the intake stroke by the cam shaft rotation for inlet valves. Usually, according to an engine speed, valve timing is changed from basic valve timing. Drawing 5 expresses the tooth lead angle, or the valve timing and the timing field when carrying out a lag from basic valve timing. Drawing 6 is valve-opening closing line drawing at the time of a tooth lead angle and a lag. Here, TDC expresses a top dead center and BDC expresses the bottom dead point. While the inlet valve is carrying out the tooth lead angle, an aperture closes an inlet valve by IVO2, and an inlet valve closes it by IVC2. On the other hand, an inlet valve is closed by IVO1 and it closes an inlet valve by the aperture and IVC1, while the inlet valve is carrying out the lag. As mentioned above, the inlet valve will also open the inside of a compression stroke, and a real compression ratio falls, so that it may understand and the lag of the inlet valve is carried out. If a real compression ratio falls, the knocking field to engine ignition timing will become able [knocking] to avoid, in order to move to a tooth-lead-angle side.
[0051] However, it is better to depend to early knocking like the gestalt of this operation at ignition timing, when it is going to avoid knocking by inhalation air content control and the burden to an engine etc. is taken into consideration compared with the knocking evasion by the ignition timing lag, since the sensitivity to knocking is low. Therefore, as for the amount of lags of an inlet valve, it is desirable to consider as a setup in consideration of the amount of ignition timing lags of the degree from which an exhaust-gas temperature, and an output and fuel consumption seldom fall victim, and the sensitivity which the air content mentioned above exerts on knocking. Next, the actuation image of the knocking judging result in the gestalt of this operation, ignition timing control, and adjustable valve train control is explained using drawing 7 and drawing 8 .
[0052] Drawing 7 (a) By knocking judging, even if judged with those with knocking, when the amount of ignition timing lags does not exceed the adjustable valve train control initiation slice level Son, adjustable valve train control (inlet-valve lag) is not performed, but knocking is avoided only by the ignition timing lag, as shown in - (d).
[0053] On the other hand, when it is judged with those with knocking by knocking judging and the amount of ignition timing lags exceeds the adjustable valve train control initiation slice level Son, an inlet-valve lag demand is set, by the adjustable valve train control means 501, the adjustable valve train actuator 121 is operated and the lag of the closing motion stage of an inlet valve 123 is carried out. Consequently, generating of knocking is avoidable.
[0054] If the amount of ignition timing lags decreases below to the adjustable valve train decontrol slice level Soff, an inlet-valve lag demand will be canceled, and the tooth lead angle of the closing motion stage of an inlet valve 123 will be gradually carried out by control by the adjustable valve train control means 501 so that the closing motion stage of an inlet valve 123 may serve as a basic actuation angle (basic valve timing).
[0055] By performing the above control, compared with the case where there is no adjustable valve train control by this invention, the time amount to which the lag of the ignition timing is carried out becomes short, and the amount of lags by ignition timing can also be stopped sharply. Moreover, the rebound phenomenon to operability can also be stopped by returning an inlet-valve lag gradually to the

minimum.
[0056] Drawing 8 shows the case where a predetermined value is set up with 0, when ignition timing returns the adjustable valve train decontrol slice level Soff at a fundamental-points fire stage. In addition, operations sequence is as drawing 7 having explained. In this control characteristic, since the lag of the inlet valve 123 is carried out until ignition timing returns at a fundamental-points fire stage, an engine inhalation-of-air property is stabilized and operability improves. However, since ignition timing lag time amount becomes long, it is more disadvantageous than the case of the control characteristic shown in drawing 7 to an exhaust-gas temperature, an output, and fuel consumption. However, the effect that the time amount to which the lag of the ignition timing is carried out becomes short compared with the case where there is no control by this invention, and the amount of lags by ignition timing can also be stopped sharply is acquired. By the above, the amount of ignition timing lags and ignition timing lag time amount can be decreased by using the knocking control by the gestalt of this operation, avoiding knocking.
[0057] Drawing 9 shows the gestalt of other operations of the knocking control unit by this invention. In addition, in drawing 9 , the portion corresponding to drawing 2 attaches the same sign as the sign given to drawing 2 , and omits the explanation. With the gestalt of this operation, as a charging-efficiency adjustable means by which an internal combustion engine's charging efficiency can be changed, it replaces with the adjustable valve train control means 501, and the throttle control means 901 is formed in the knocking control unit 900.
[0058] In addition, the fundamental input of the knocking control unit 900, fuel-injection control, ignition control, etc. are the same as that of the knocking control unit 300 explained by drawing 2 , and are as having mentioned above. A different point is that the analog input of the accelerator opening sensor 902 and the throttle opening sensor 903 is carried out as information which is needed for throttle control. The processing after an input is the same as that of the knock sensor 117 grade explained by drawing 2 . Moreover, it is as having also mentioned the knocking judging means 303 above.
[0059] The throttle control means 901 is the same method as the above-mentioned, inputs engine water temperature and the vehicle speed, and inputs the amounts of engine ignition timing adjustments (the amount of lags etc.) which are the judgment result of the existence of knocking, and the result of an operation of the ignition timing control means 304 by the knocking judging section 303. From these input, the throttle control means 901 calculates the optimal throttle opening, outputs the output signal of the throttle motor 120 which carries out the closing motion drive of the throttle valve 104 to the throttle motor 120 through the drive circuit 322, and controls throttle opening. According to operational status, the throttle motor 120 is driven freely, and throttle opening can be controlled by the above control.
[0060] Drawing 10 shows the flow chart of the throttle control action using the amount of ignition timing amendments. First, the processing flow shown in drawing 3 performs knocking judging processing and ignition timing amendment control by the knocking judging means 303 and the ignition timing control means 304 (step 221).
[0061] Next, it distinguishes whether it is beyond the predetermined value (slot closing control initiation slice level Son') as which the amount of ignition timing amendments (the amount of ignition timing lags = the amount of ignition timing retard) was inputted, and the amount of ignition timing retard was beforehand determined from the ignition timing control means 304 (step 222).
[0062] If ignition timing is under predetermined value Son' even if it is carrying out knocking generating, throttle control will not be performed but control will be ended as it is. By this, when the amount of ignition timing lags is small, throttle closing control is not performed, but the usual operability can be secured.
[0063] On the other hand, if the amount of ignition timing retard is more than predetermined value Son', it will distinguish whether the usual throttle control has already been performed by the throttle control means 901 (step 223). If the usual throttle control is performed, the usual throttle control will already be forbidden (step 224). Even if knocking has occurred depending on operational status, for the improvement in operability (for example, throttle control for a torque demand), the throttle valve 104 may be opened and, in such a case, open Lycium chinense is forbidden for a throttle valve 104.

[0064] Next, closing (step 225) and knocking are avoided for a throttle valve 104 by the throttle motor 120 for knocking evasion. A throttle valve 104 is later mentioned about a setup of the amount of closing. Next, it distinguishes whether it is beyond the predetermined value (throttle closing decontrol slice level Soff') as which the amount of ignition timing amendments (the amount of ignition timing lags = the amount of ignition timing retard) was inputted, and the amount of ignition timing retard was beforehand determined from the ignition timing control means 304 (step 226). However, it is Son'>Soff' about the amount of ignition timing lags also in this case.
[0065] if the amount of ignition timing lags is larger than predetermined value Soff' -- throttle closing control -- continuing -- on the other hand, ignition timing value **** -- predetermined value Soff' -- if it decreases to the following, a throttle closing demand will be canceled, and the throttle motor 120 will open a throttle valve 104 so that it may become basic throttle opening (step 227). Here, as for valve opening (closing discharge of a throttle valve) of a throttle valve 104, it is desirable to consider operability and to carry out gradually from a twist, the time of the amount of ignition timing lags decreasing under to predetermined value Soff'.
[0066] Moreover, when ignition timing returns at a fundamental-points fire stage, predetermined value Soff' here is setting up predetermined value Soff' with 0, the inhalation of air to an engine is stabilized by it, and its operability improves. However, since the time amount which is carrying out the lag of the ignition timing becomes long, to an exhaust-gas temperature, fuel consumption, and an output, it becomes disadvantageous. For details, it mentions later.
[0067] Next, the method of setting up the amount of throttle closing for the knocking evasion in the gestalt of this operation is explained. Compared with the adjustable valve train control which mentioned above the method of lowering a charging efficiency by throttle opening control since an air content did not change rapidly to the engine, effectiveness is inferior. As for the amount of closing of a throttle valve, it is desirable to be set up in consideration of the knocking evasion field by the ignition timing lag, the charging efficiency which falls by closing a throttle, and operability. Next, the knocking judging result in the gestalt of this operation and the actuation image of the amount of ignition timing lags and throttle control are explained using drawing 11 and drawing 12 .
[0068] In drawing 11 , by knocking judging, even if judged with those with knocking, when the amount of ignition timing lags does not exceed throttle closing control initiation slice level Son', throttle closing control is not performed but knocking is avoided only by the ignition timing lag. On the other hand, when it is judged with those with knocking by knocking judging and ignition timing exceeds throttle closing control initiation slice level Son', a throttle closing control demand is set, by the throttle control means 901, the throttle motor 120 is operated and a throttle valve 104 is closed. Consequently, the inhalation air content to an engine 100 decreases, and since a charging efficiency falls, generating of knocking is avoidable.
[0069] If the amount of ignition timing lags decreases below to throttle closing control initiation slice level Soff', a throttle closing demand is canceled, and control by the throttle control means 901 opens the throttle valve 104 gradually so that it may become basic throttle opening.
[0070] By performing the above control, compared with the case where there is no control by this invention, the time amount to which the lag of the ignition timing is carried out becomes short, and the amount of lags by ignition timing can also be stopped sharply. Moreover, the rebound phenomenon to operability can also be stopped by returning throttle opening gradually to the minimum.
[0071] Drawing 12 shows the case where a predetermined value is set up with 0, when ignition timing returns throttle closing decontrol slice level Soff' at a fundamental-points fire stage. In addition, operations sequence is as drawing 11 having explained. In this control characteristic, since throttle closing control is performed until a fundamental-points fire stage comes and an engine inhalation-of-air property is stabilized, operability improves. However, since ignition timing lag time amount becomes long, it is more disadvantageous than the case of the control characteristic shown in drawing 11 to an exhaust-gas temperature, an output, and fuel consumption. However, compared with the case where there is no control by this invention, the time amount to which the lag of the ignition timing is carried out becomes short, and the amount of lags by ignition timing can also be stopped sharply.

[0072] By the above, the amount of ignition timing lags and time amount can be decreased by using the knocking control means by the gestalt of this operation, avoiding knocking. Moreover, when the amount of ignition timing lags decreases, an engine can be formed into a high compression ratio and the improvement in fuel consumption and the improvement in an output can be expected. As mentioned above, although the gestalt of 1 operation of this invention was explained, this invention can perform various modification in layout etc., without deviating from the pneuma of invention indicated by the claim, without being restricted to the gestalt of said operation.
[0073] For example, it is also possible to combine the knocking control means using an adjustable valve train control means and the knocking control means using a throttle control means. Being able to make the burden to each means small and raising operability further by performing control of avoiding early knocking by the ignition timing lag, then carrying out the lag of the inlet valve, and finally closing a throttle, since the sensitivity to knocking is high in order of (1) ignition-timing lag (2) inlet-valve lag (3) throttle closing **, knocking can be avoided and the amount of ignition timing lags and time amount can also be lessened.
[0074]
[Effect of the Invention] According to the knocking control unit of the internal combustion engine by this invention, so that he can understand from the above explanation An ignition timing control means follows the judgment result of a knocking judging means, and if the judgment result concerned is with knocking An ignition timing control means carries out the lag of an internal combustion engine's ignition timing, and it responds to the lag of an internal combustion engine's ignition timing. For example The amounts of lags and lag time amount of the ignition timing by knocking are reducible, securing engine operation nature, since reducing an internal combustion engine's charging efficiency with the charging-efficiency adjustable means by the adjustable valve train control means, a slot control means, etc. is performed, if the amount of lags of ignition timing becomes beyond a predetermined value. As a result, the rise of the exhaust-gas temperature produced by the ignition timing lag, aggravation of fuel consumption, and the fall of an output can be suppressed to the minimum. Moreover, since an engine can be formed into a high compression ratio when the amount of ignition timing lags decreases, the improvement in fuel consumption and the improvement in an output are expectable.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] A knocking detection means to detect knocking vibration generated in an internal combustion engine A knocking judging means to judge existence of knocking based on a knocking detecting signal which said knocking detection means outputs An ignition timing control means which controls an internal combustion engine's ignition timing A charging-efficiency adjustable means by which an internal combustion engine's charging efficiency can be changed Said ignition timing control means follows a judgment result of said knocking judging means, it is the knocking control unit of an internal combustion engine having the above, if the judgment result concerned is with knocking, said ignition timing control means will carry out the lag of an internal combustion engine's ignition timing, and said charging-efficiency adjustable means is characterized by reducing an internal combustion engine's charging efficiency according to a lag of an internal combustion engine's ignition timing.
[Claim 2] Said charging-efficiency adjustable means is the knocking control unit of an internal combustion engine according to claim 1 characterized by being the adjustable valve train control means to which the lag of the closing motion stage of an internal combustion engine's inlet valve is carried out with an actuator.
[Claim 3] A knocking control unit of an internal combustion engine according to claim 2 characterized by carrying out the lag of the clausilium stage of an inlet valve with said good fluctuation valve-control means when knocking is judged by said knocking judging means to be owner ** and ignition timing carries out a lag beyond a predetermined value by said ignition timing control means.
[Claim 4] Lag discharge of a clausilium stage of an inlet valve is the knocking control unit of an internal combustion engine according to claim 2 characterized by carrying out gradually from a twist a time of the amount of ignition timing lags decreasing below to a predetermined value.
[Claim 5] During knocking control, it is the knocking control unit of an internal combustion engine according to claim 2 characterized by forbidding inlet-valve control by said good fluctuation valve-control means according to an internal combustion engine's operational status, and performing preferentially inlet-valve lag control for knocking evasion.
[Claim 6] Said charging-efficiency adjustable means is the knocking control unit of an internal combustion engine according to claim 1 characterized by being the throttle control means which reduces an internal combustion engine's throttle opening with an actuator.
[Claim 7] A knocking control unit of an internal combustion engine according to claim 6 characterized by closing a throttle valve by said throttle control means when knocking is judged by said knocking judging means to be owner ** and ignition timing carries out a lag beyond a predetermined value by said ignition timing control means.
[Claim 8] Closing discharge of a throttle valve is the knocking control unit of an internal combustion engine according to claim 6 characterized by carrying out gradually from a twist a time of the amount of ignition timing lags decreasing below to a predetermined value.
[Claim 9] During knocking control, it is the knocking control unit of an internal combustion engine according to claim 6 characterized by forbidding throttle control by said throttle control means

according to an internal combustion engine's operational status, and performing throttle closing control for knocking evasion preferentially.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The whole block diagram showing the engine system whole configuration equipped with the knocking control unit concerning the gestalt of 1 operation of this invention.
[Drawing 2] The functional block diagram of the knocking control unit of the internal combustion engine concerning the gestalt of 1 operation of this invention.
[Drawing 3] The flow chart of the ignition timing control action of the knocking control unit shown in drawing 2 .
[Drawing 4] The flow chart of the adjustable valve train control action using the amount of ignition timing amendments of the knocking control unit shown in drawing 2 .
[Drawing 5] The graph showing the operating range of adjustable valve timing.
[Drawing 6] The timing chart showing the operating range of adjustable valve timing.
[Drawing 7] (a) -- an example of actuation of adjustable valve train control of the knocking equipment with which - (d) was shown in drawing 2 -- being shown -- drawing -- it is -- (a) -- a knock judging result -- (c) shows an inlet-valve lag demand and, as for (b), (d) shows the inlet-valve actuation image for the relation between ignition timing and adjustable valve train control respectively.
[Drawing 8] (a) -- drawing showing other examples of actuation of adjustable valve train control of the knocking equipment with which - (d) was shown in drawing 2 -- it is -- (a) -- a knock judging result -- (c) shows an inlet-valve lag demand and, as for (b), (d) shows the inlet-valve actuation image for the relation between ignition timing and adjustable valve train control respectively.
[Drawing 9] The functional block diagram of the knocking control unit of the internal combustion engine concerning the gestalt of other operations of this invention.
[Drawing 10] The flow chart of the throttle control action using the amount of ignition timing amendments of the knocking control unit shown in drawing 9 .
[Drawing 11] (a) -- drawing showing an example of actuation of adjustable valve train control of the knocking equipment with which - (d) was shown in drawing 9 -- it is -- (a) -- a knock judging result -- (c) shows a throttle closing demand and, as for (b), (d) shows the throttle motor actuation image for the relation between ignition timing and throttle closing control respectively.
[Drawing 12] (a) -- drawing showing other examples of actuation of adjustable valve train control of the knocking equipment with which - (d) was shown in drawing 9 -- it is -- (a) -- a knock judging result -- (c) shows a throttle closing demand and, as for (b), (d) shows the throttle motor actuation image for the relation between ignition timing and throttle closing control respectively.
[Description of Notations]
100. Engine
103. Intake Air Flow Sensor
104. Throttle Valve
110. Fuel Injector
112. Ignition Coil
113. Ignition Plug

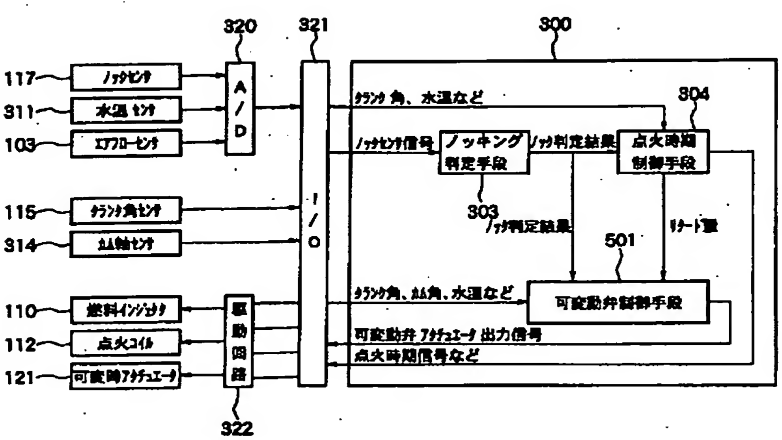
114. Engine Control System
115. Crank Angle Sensor
116. Crankshaft
117. Knock Sensor
118. Adjustable Valve Train Controlling Mechanism
119. Cam Shaft
120. Throttle Motor
121. Throttle-Valve Equipment
122. Accelerator Pedal 123: Inlet Valve
300. Knocking Control Unit
303. Knocking Judging Means
304. Ignition Timing Control Means
501. Adjustable Valve Train Control Means
901. Throttle Control Means

[Translation done.]

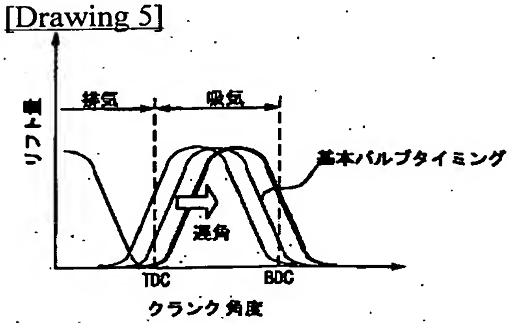
* NOTICES *

DRAWINGS

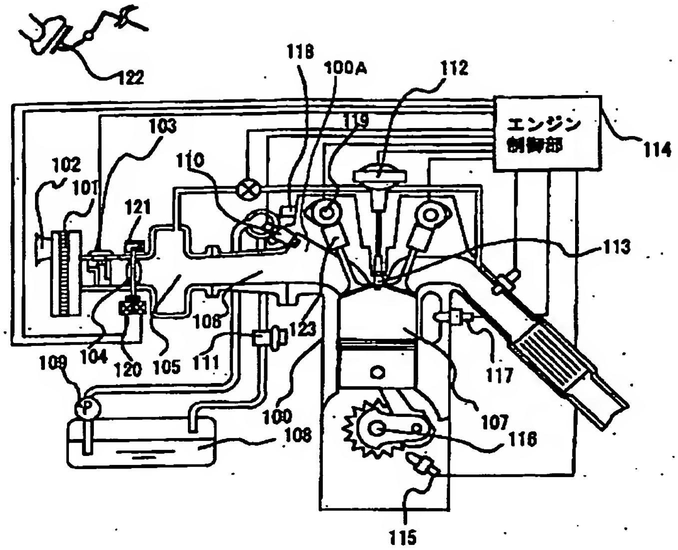
[Drawing 2]



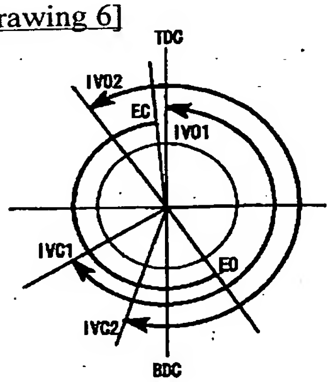
[Drawing 5]



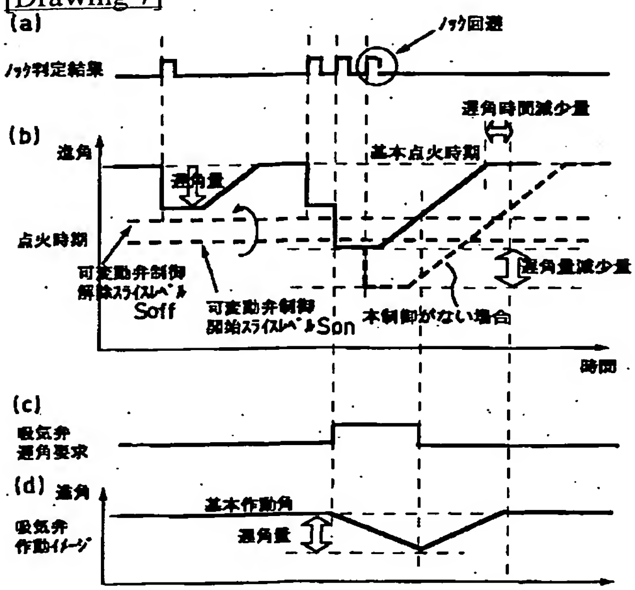
[Drawing 1]



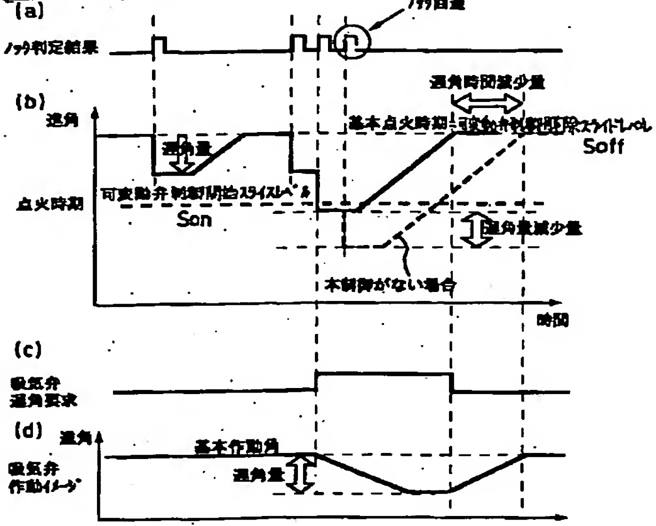
[Drawing 6]



[Drawing 7]



[Drawing 8]



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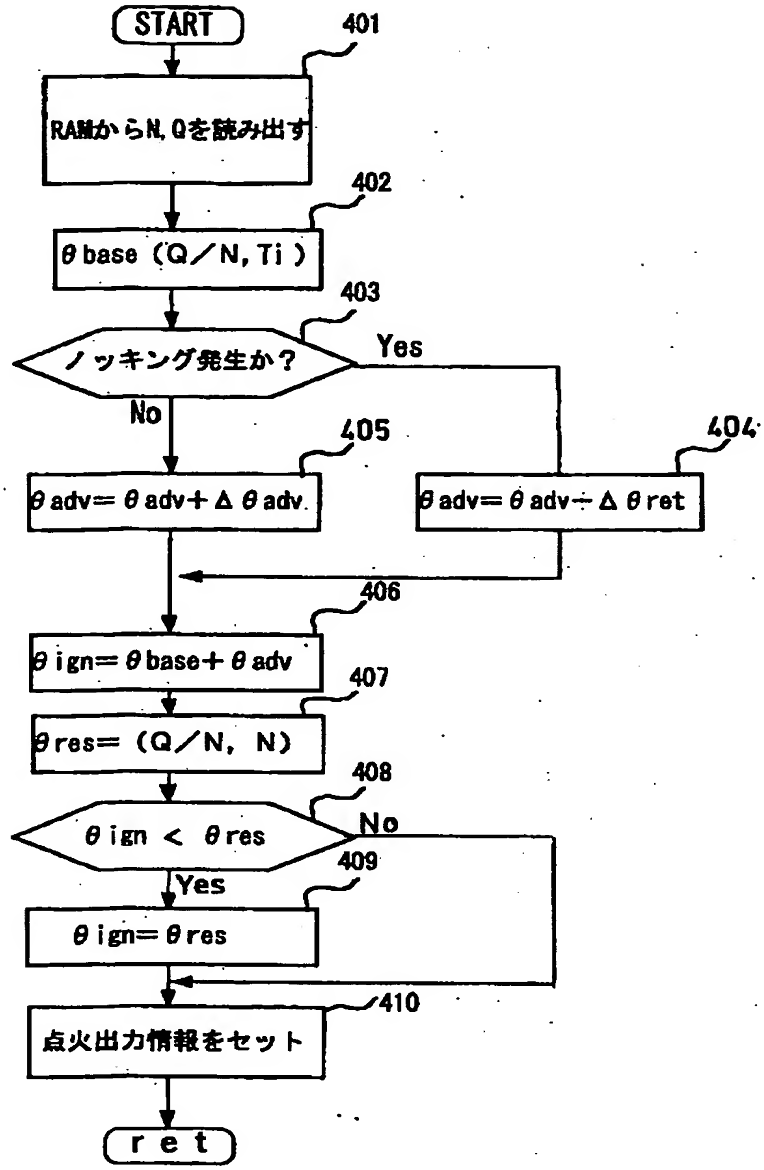
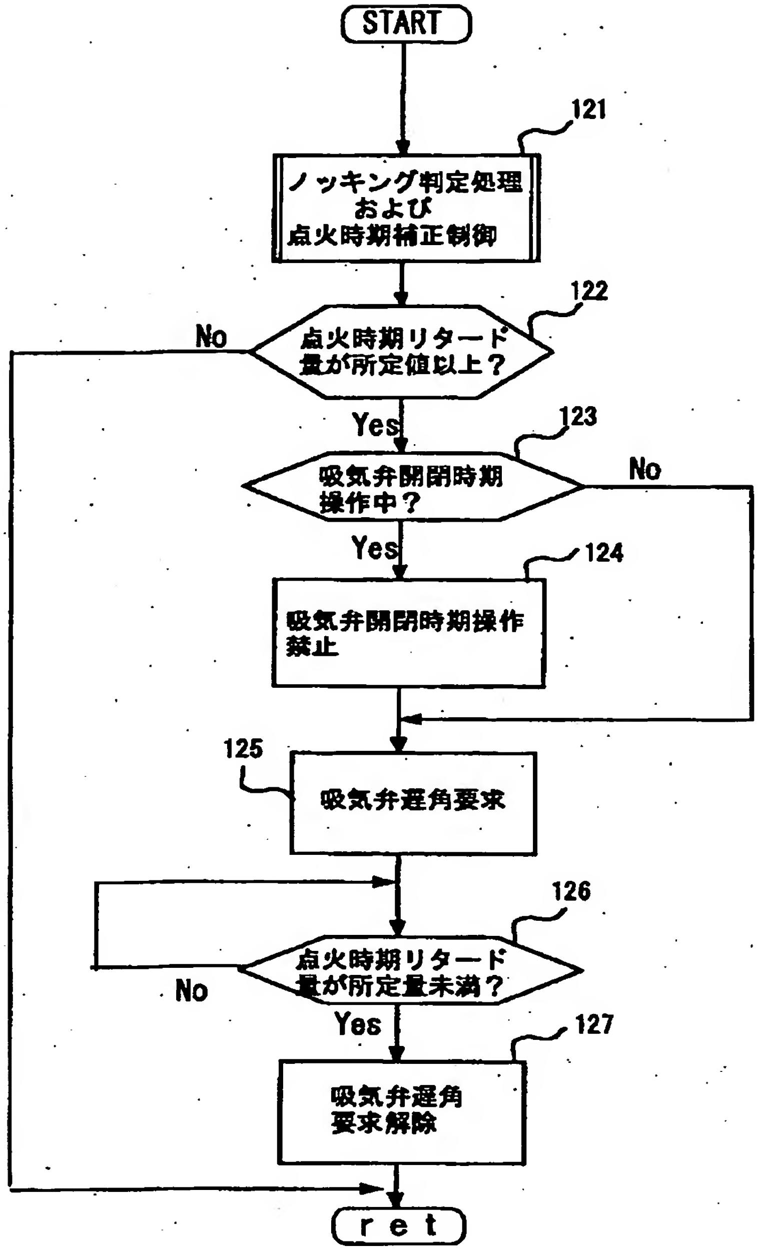
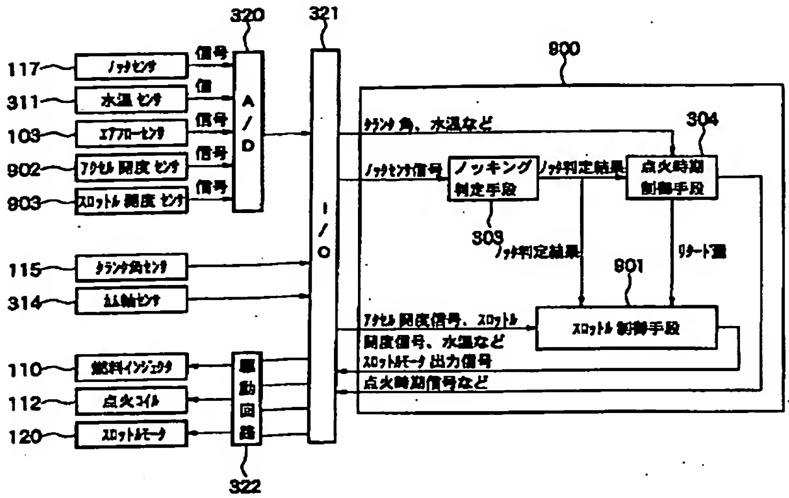

START
401
RAMからN, Qを読み出す
402
θbase（Q／N, Ti）
403
ノッキング発生か？
Yes
No
405
404
θadv＝θadv＋Δθadv
θadv＝θadv－Δθret
406
θign＝θbase＋θadv
407
θres＝（Q／N, N）
408
θign ＜ θres
No
409
Yes
θign＝θres
410
点火出力情報をセット
r e t

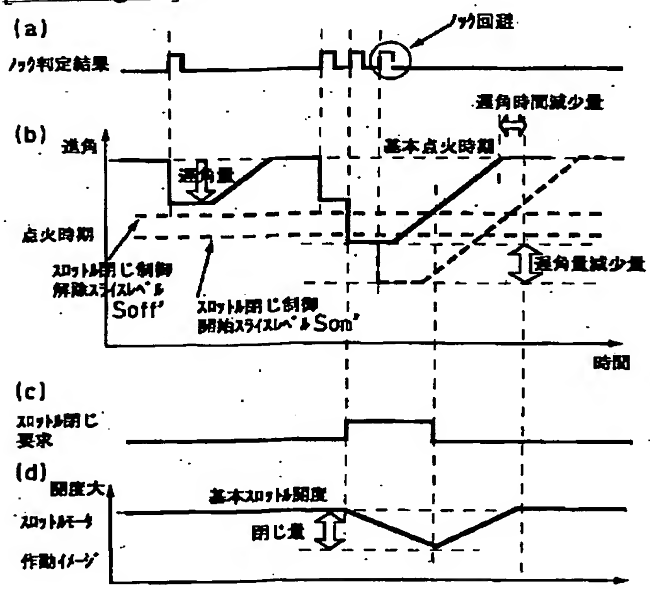
[Drawing 4]


START
121
ノッキング判定処理
および
点火時期補正制御
122
No
点火時期リタード
量が所定値以上？
Yes
123
吸気弁開閉時期
操作中？
No
Yes
124
吸気弁開閉時期操作
禁止
125
吸気弁遅角要求
126
点火時期リタード
量が所定量未満？
No
Yes
127
吸気弁遅角
要求解除
r e t

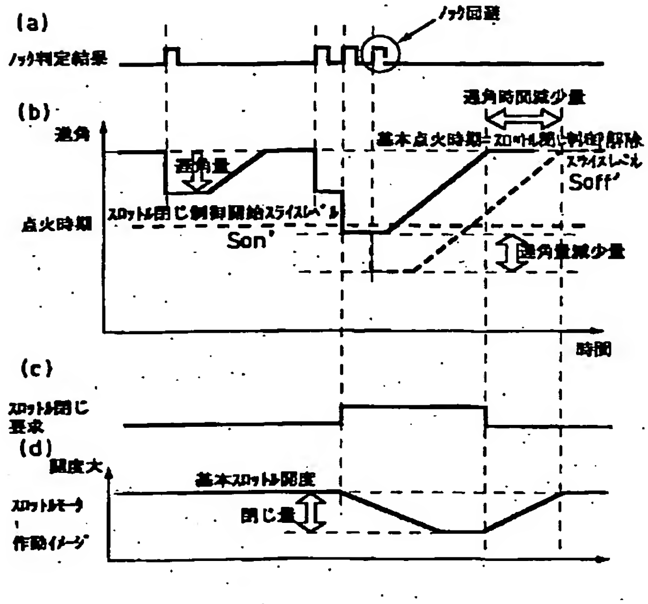
[Drawing 9]



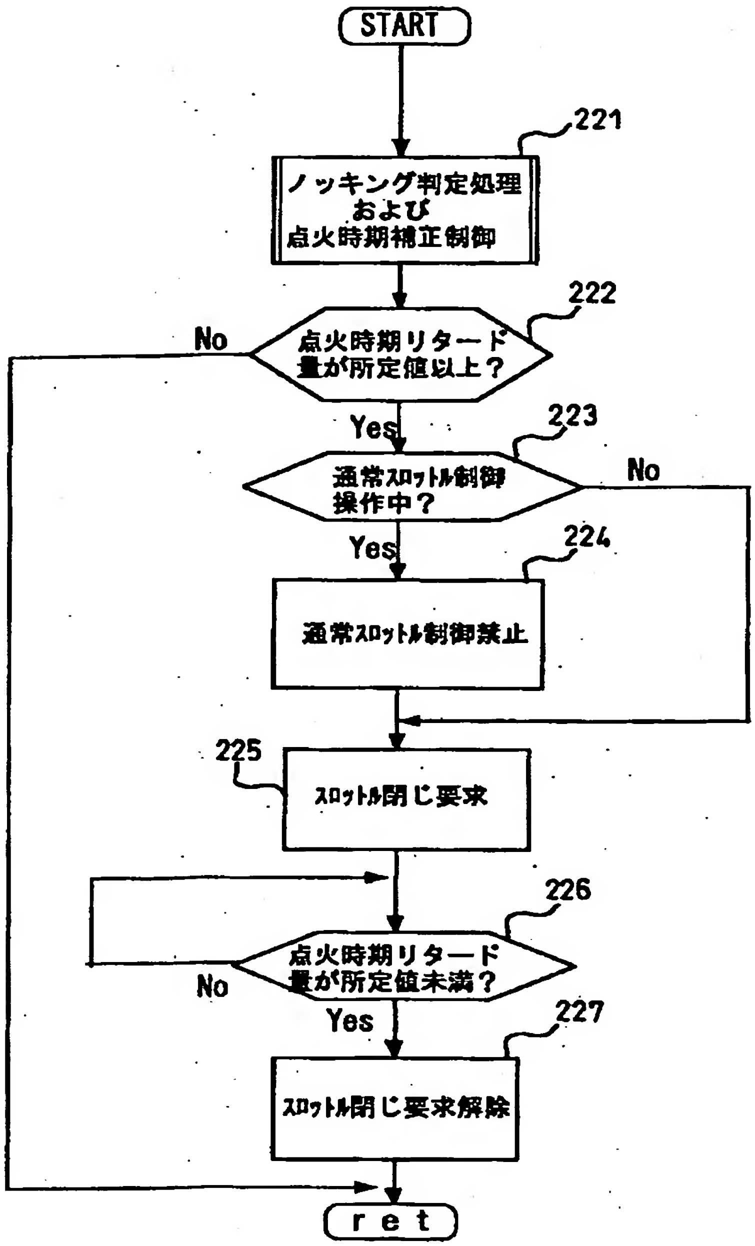
[Drawing 11]



[Drawing 12]


(a)
ノック判定結果
ノック回避
(b)
進角
遅角時間減少量
基本点火時期
スロットル閉じ制御解除スライスレベル
Soff'
遅角量
点火時期
スロットル閉じ制御開始スライスレベル
Son'
遅角量減少量
時間
(c)
スロットル閉じ要求
(d)
開度大
基本スロットル開度
スロットルモータ作動イメージ
閉じ量

[Drawing 10]



[Translation done.]